JULY 1967

AGRICULTURAL Research

U.S. DEPARTMENT OF AGRICULTURE

WASP CONTROLS GRASSLAND PEST
Page 3

AGRICULTURAL
Research
July 1967/Vol. 16, No. 1

Imported Aids

Plants, insect predators, and livestock from all over the world are helping to increase the variety and quality of American agriculture.

Foreign crops with desirable characteristics help ARS plant breeders improve the quality of our own crops. The high-yielding, high-protein wheat strains from Africa, India, and Brazil, for example, may help ARS breeders develop high-yielding domestic wheats with increased protein content. Protein content in domestic wheat usually drops as yields go up.

ARS explorers search the world for plants that may serve as new crops for American farms. A recent example is crambe, brought to the United States from the shores of the Mediterranean. Oil from American-grown crambe is already in demand as a lubricant for steel casting and shows promise in many other industrial applications.

Ornamental plant introductions also beautify our homes and gardens; they include the Chinese elm, ornamental willows, some bamboos, and Zoysia grass. The famous cherry trees of Washington, D.C., were a gift from Japan.

In addition, a drug from the bark of an obscure tree from China introduced more than 30 years ago, may prove useful for arresting certain forms of leukemia. ARS botanists are intensively searching the world for other plants containing cancer-inhibiting substances.

We also go overseas to obtain valuable biological weapons to use against destructive pests. A wasp from India, for example, effectively controls the Rhodesgrass scale, a grassland pest that has ruined pastures in the Gulf Coast States for nearly 30 years (p. 4).

Wasp introductions from Europe are also helping control the European stem sawfly and the alfalfa weevil, a pest that spread rapidly in the East because of the lack of natural enemies. Four wasp species effectively control the citrus blackfly in Mexico and thus prevent its entering the United States, to cite other examples.

And, of course, many of our traditional breeds of livestock were developed abroad originally, and livestock is still imported to improve the quality of our breeds. In recent years, several beef cattle breeds from India, noted for heat tolerance, were used as crosses in developing the American Brahman, a popular cattle breed in the South. Charolais cattle came from France and are noted for superior growth rate and ability to produce lean carcasses.

Editor: R. P. Kaniuka
Contributors to this issue:
H. L. Brinson, B. D. Carriere, E. H. Davis, Marshall Gall, M. B. Heppner, J. G. Nordquist, N. E. Roberts, D. M. Webb, A. D. Wynn

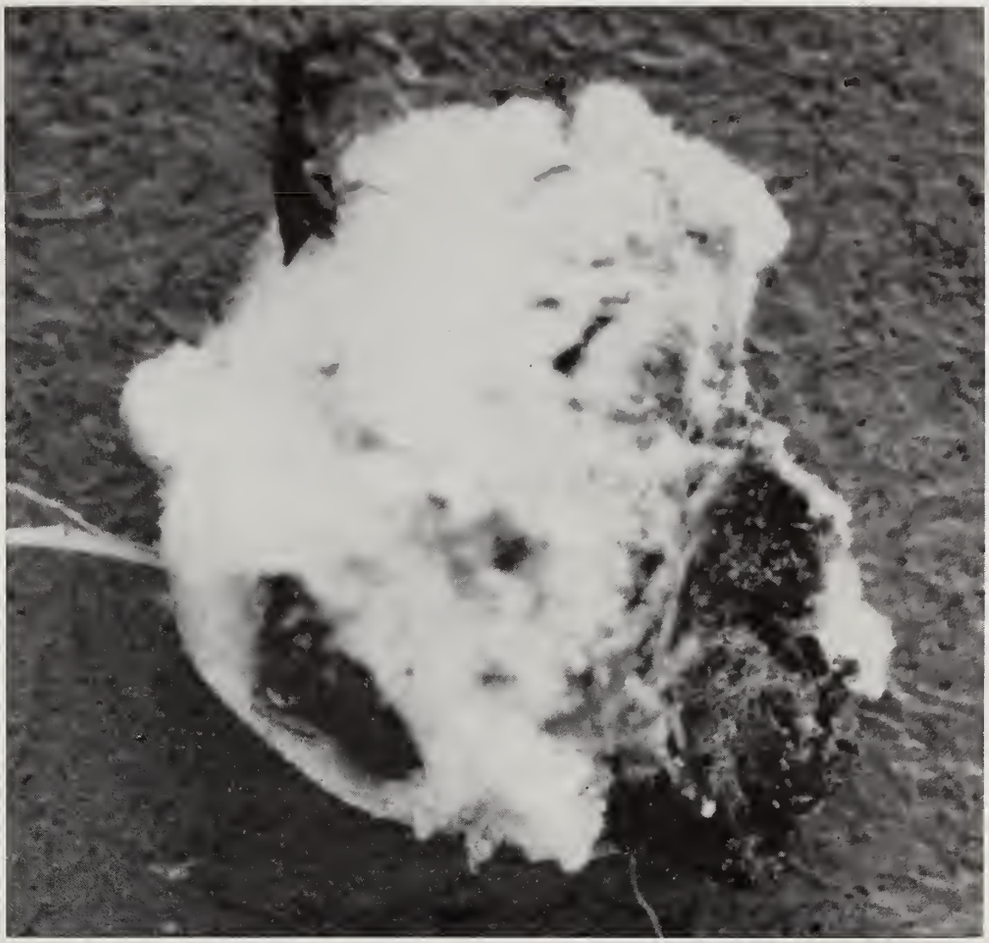
AGRICULTURAL RESEARCH is published monthly by the Agricultural Research Service (ARS), United States Department of Agriculture, Washington, D.C. 20250. Printing has been approved by the Bureau of the Budget, August 15, 1958. Yearly subscription rate is $1.50 in the United States and countries of the Postal Union, $2.00 in other countries. Single copies are 15 cents each. Subscription orders should be sent to Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Information in this periodical is public property and may be reprinted without permission. Mention of the source will be appreciated but is not required.

Orville L. Freeman, Secretary
U.S. Department of Agriculture

G. W. Irving, Jr., Administrator
Agricultural Research Service

PN–1501

PN–1511



The cover: A Rhodesgrass scale colony on the crown of young Rhodesgrass. Right: A female wasp deposits eggs in the Rhodesgrass scale. The white waxy globe is a hollow covering secreted by the scale.

WASP CONTROLS GRASSLAND PEST

A SMALL WASP from India may control a big insect pest of grasslands here.

The insect, Rhodesgrass scale (*Antonina graminus*), has ruined pastures in the Gulf Coast States for nearly 30 years and is found on golf courses and lawns in Arizona and California as well. Rhodesgrass is the scale's main host, but the insect attacks more than 90 grass species including Bermudagrass, Paragrass, and St. Augustine. Insecticides are either ineffective, too toxic, or too expensive for general use on pastures and lawns.

ARS entomologist G. W. Angalet discovered the wasp, *Neodusmetia sangwani,* near New Delhi and Bangalore, India, while searching for parasites of cotton pests. The wasp lays its eggs in the scale, which dies when the eggs hatch. As many as 10 young wasps emerge from each scale and produce a new generation of wasps in as little as 27 days, extending control of the scale pest without the aid of man.

In 1964, wasps were released experimentally on 900,000 acres in south central Texas under the direction of entomologist M. F. Schuster of Texas A. & M. During the past 2 years, it reduced scale populations 50 percent and increased pasture density, which is essential for good grazing and conservation, by 80 percent. The wasp does not attack beneficial insects or crops.

Under ARS contract, Texas A. & M. is now rearing thousands of wasps for release from airplanes, a modified version of an air-drop technique ARS developed a few years ago to eradicate the screwworm. In current tests under range conditions, scientists are adjusting release

rate to achieve 90 percent parasitization in 1 year. Costs for rearing and distributing wasps are only 34 cents per square mile.

Mass releases will be necessary for some time, however. The females, which constitute most of the releases, are wingless and travel only short distances from their release sites.

Brazil and other countries are also interested in the wasp as a scale control. The scale, found in all tropical and subtropical regions of the world, has seriously reduced meat production. With the increased pasturage made possible by the wasp, these countries could, for the first time, produce livestock on a commercial scale and enrich the protein-starved diets of millions of people.

In the United States, the scale made its first inroads on the giant King Ranch in 1940. By 1946, it had ruined 18,000 acres of Rhodesgrass on the ranch and had spread to other ranches in the Gulf States. Pastures with a normal useful life of 8 years or longer lasted less than 3 years under scale attack.

Although ranchers could substitute other grasses, they preferred Rhodesgrass because of its high yield, forage quality, and adaptability to the hot-dry climate.

Besides diminishing pastures, the main signs of scale infestation are clusters of small (1/8 inch) soft, white waxy globes that look like abnormal growths at the base of grass plants. The insects themselves are rarely seen because they spend most of their lives inside their globular "homes" sucking the juices of the plants.

Other insect enemies of the scale appeared promising in their native habitats of Japan, Pakistan, Hawaii, and France, but failed to adapt to the climate in the United States. One exception was an Indian wasp, *A. antoninae*, that freed Paragrass of scale in Florida but was unsuccessful in other States. ■

PN–1512

The larva (top) and adult of the Rhodesgrass scale without waxy sac covering.

For Forage and Food:

DWARF PEARL MILLET

A DWARF male-sterile pearl millet from Georgia may help provide better forage for the Southeastern United States and more food for India.

In this country, the male-sterile breeding lines are used to develop superior forage hybrids. In food-short India, however, where pearl millet (bajra) is grown on more than 27 million acres and is a major source of food for millions of people, the lines help breeders develop superior grain hybrids for food production.

ARS geneticist G. W. Burton at Tifton, Ga., developed the dwarf, male-sterile pearl millet, Tift 23DA, and its fertility maintainer, Tift 23DB, as part of a forage improvement program for the Southeast. The Georgia Coastal Plains Experiment Station cooperated in the program.

Millet lines developed at Tifton have already been successfully used by plant breeders in India to produce better grain-yielding hybrids. In 1961, a male-sterile line from Tifton—Tift 23A—was furnished to Indian millet breeders who crossed it with an Indian line to produce a hybrid, HB–1. In tests throughout the bajra-growing region of India, grain yields of HB–1 averaged 88 percent more than the best local varieties with which it was compared.

The Indian geneticists now have Tift 23DA and Tift 23DB. The new breeding material appears to be identical to that furnished in 1961 except that it has a dwarf gene, which permits development of dwarf hybrids resistant to lodging.

Geneticists will use this material to develop dwarf hybrids superior in forage quality and grain-yielding ability to those from normal types.

In addition to better grain-yielding ability, hybrids based on the male-sterile lines from Tifton mature their seed uniformly in a few days, which reduces bird damage. The hybrids also have good forage value after grain harvest—an important consideration in many parts of India. ■

PUNCH PLANTING

PN–1515, PN–1516

BECAUSE THEY are tiny and fragile, many lettuce seedlings never see the light of day. Even a light crust on the soil surface is enough to keep them from breaking through and growing to maturity.

J. W. Cary, an ARS soil scientist at the Snake River Conservation Research Center in Kimberly, Idaho, solved this problem by punching holes in the soil and dropping a single lettuce seed in each hole. Lettuce and other vegetables planted this way had a good survival rate even in heavily crusted soil.

The holes need not be refilled with soil after seeding, Cary discovered. Seeds deposited at the bottom of the holes germinated, sent up shoots, and took root without benefit of soil cover. Hole depth depends on the type of vegetable being planted. Cary found that a hole 2 inches deep was best for lettuce plants.

Machines for "punch-planting" vegetables are already on the drawing board, but designers have not been able to agree on how much soil to put back into the hole to cover the seed. If, as Cary's research indicates, the answer is "none," the design task should be that much simpler.

Cary used a 3- by 5-foot tray of soil to compare punch-planting with conventional planting. When growing conditions in the tray were ideal—that is, when soil was kept loose and moist—the conventionally planted seeds grew slightly faster than the punch-planted seeds. But when water was applied sparingly, or when a fan was turned on the soil to increase drying and crusting, the punch-planted seeds far exceeded the conventionally planted seeds in germination and growth rates.

Aside from eliminating the crust problem, punch-planting puts the seed deeper in the soil, where it has access to more moisture during germination and early growth. Also, temperature of the lettuce seeds at the bottom of the holes was several degrees lower than in normal seedbeds—an advantage in hot-weather areas such as the Southwest.

In field tests, Cary punch-planted carrots, sweet corn, sugar beets, cabbage, potatoes, and beans, as well as lettuce. He experimented with different hole depths and widths for each vegetable.

Most of the punch-planted vegetables grew well provided there was some moisture at the bottom of the hole and provided the holes did not fill with soil after seeding. Beans planted in holes 5–8 inches deep grew especially well.

Cary's work should make vegetable growing more profitable in areas troubled by marginal rainfall and drying winds. On irrigated land, it should reduce the number of irrigations needed to get a vegetable crop started because it allows seeds to use more subsoil moisture. ■

Above: Punch-planted carrot seedlings emerge from their holes. The heavy crust on the soil would have prevented emergence of conventionally planted seeds. Below: A plot of punch-planted vegetables in Colorado.

Food technologist F. B. Talley hands a meat sample to one of the taste panelists.

PN–1513

IDENTIFYING MEAT FLAVORS

THERE'S A WORLD of difference between a piece of roast beef and a pork chop, a lamb chop and a veal cutlet, but does the difference lie in the lean, the fat, the color, or the texture?

To learn the answer to this question and so help stimulate the market for a wide variety of meats, chemist A. E. Wasserman and food technologist F. B. Talley of the ARS Eastern utilization laboratory, Philadelphia, conducted a series of meat flavor tests.

In the first test, the researchers removed the fat from four different meats, roasted them, and asked a taste panel to identify them. The meats were an eye roast of beef, a veal shoulder roast, the rump end of a leg of lamb, and the loin end of a pork loin.

Less than half of the tasters were able to identify correctly the lamb and the veal. The beef and pork were picked out about three-fourths of the time, but were identified more by color and texture than by flavor. When the four meats were ground with fat removed, none of them could be identified correctly by more than half the tasters.

Earlier tests indicated that fat determines characteristic flavors. To confirm this, Wasserman repeated the test with four ground meats, allowing the fat to remain. Between 70 and 80 percent of the tasters then correctly identified the lamb and beef samples, but the added fat had little effect on the identifiability of the ground pork and veal samples.

Since veal is the blandest of the four meats and the one with the least fat, the experimenters used it to determine the flavor strength of the fats from the other three meats. First, they served samples of plain veal, ground and roasted. Only about a third of the tasters identified it correctly; another third said it was beef, 24 percent called it pork, and 11 percent thought it was lamb.

If the characteristic flavor of the other meats is in the fat, the percentages calling veal beef, pork or lamb should be increased by adding the fats of these meats. When this was done, 40 to 50 percent of the tasters identified all the samples as the meat from which the added fat had come—significantly more than those who had identified the plain veal as lamb or pork, but only slightly more than those to whom the plain veal tasted like beef.

Wasserman also tried to establish whether the fats themselves, or certain water-soluble compounds in them, are primarily responsible for the characteristic flavors that fats impart.

He removed these compounds from beef, lamb, and pork fat and added the fat to samples of ground veal as before. When extracted lamb fat was added to veal, the percentage identifying it as lamb shot up to about 70, almost as readily identifiable as the ground lamb samples themselves. On the other hand, extraction deprived the pork fat of its power to disguise veal as pork, while extraction of the beef fat had very little effect.

Wasserman concluded that lamb may be the only meat whose characteristic flavor can be attributed to fat. This may also be true to a lesser extent with pork, although here the flavor compounds may well be in the water-soluble compounds in the fat.

The role of beef fat in flavor appears to be much less certain. Some components of this meat other than fat may determine its characteristic flavor. ■

For Northern Great Plains

RANGE INTERSEEDER

RANGE INTERSEEDERS, tillage tools that renovate ranges and boost forage yields, have been developed for the tough clay soils of the northern Great Plains.

After test treatments with the new interseeder, high-producing native grasses that had all but disappeared from test ranges reestablished themselves and spread rapidly. The treatments also increased moisture catch and reduced competition from the dominant, but less productive, blue grama grass.

Interseeders simultaneously furrow and seed strips of range land. The business end of these machines is a two-edged, flat plow bottom known as a middlebuster. It undercuts sod 2 to 3 inches below the surface, turns the sod over, and places it on both sides of a furrow 20 to 22 inches wide. Furrows are spaced 4 to 5 feet apart, leaving about 1½ feet of uncovered sod between the inverted strips. As the strips are cut, the machine plants grass, legume, or browse seed.

The concept of interseeding is not new. As long ago as 1899, some Texas ranchers plowed spaced furrows across rangeland to catch moisture and wind-blown grass seed. But specialized equipment, at first unavailable, was later made only in small shops from locally available parts.

The lack of ready-made parts made standards for the machines difficult to set. In addition, machines adapted to the immediate area where they were made were often poorly suited to other parts of the Great Plains.

To fill this gap, ARS range scientist W. R. Houston at Miles City, Mont., and R. A. Adams of the Department of Interior's Bureau of Land Management, built the heavy-duty interseeder for the rough topography and clay soils of the northern Great Plains. Their machine, designed with commercially available parts, consists of a three-point hitch with toolbar, middlebuster plow bottoms, and beet-seed planters.

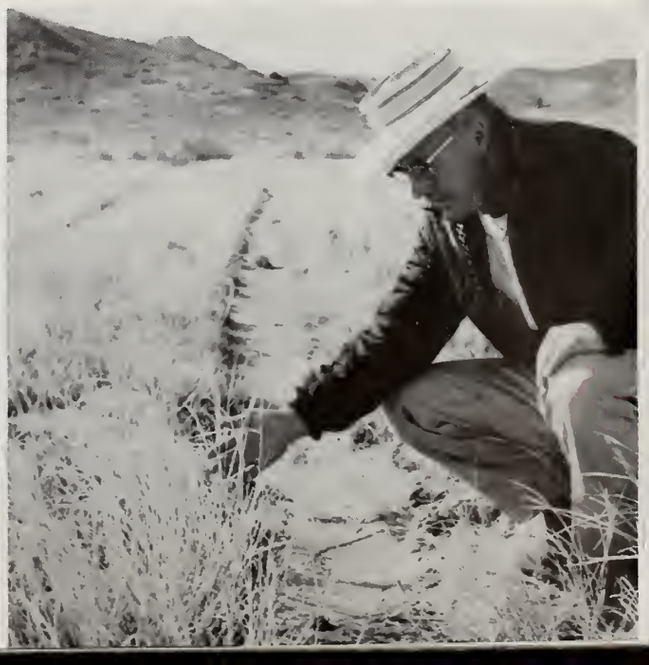
In recent pilot tests, the machine performed well at a total cost between $3 and $5 per acre, plus seed.

For greater efficiency, Houston and Adams modified the parts used, increasing the height of the plow wings and adding guards to prevent brush and chunks of sod from jamming the seeder chains. They also installed a trip mechanism between the plow bottoms and shanks to avoid damage when shears catch on rocks. The seeder was modified to lift higher on turns and prongs were welded between the shears and shanks to loosen the hard-packed soil in the bottom of the furrow.

Preliminary studies by the Montana Agricultural Experiment Station indicate that grasses seeded in the interseeder furrow may require 3 to 5 years to contribute significantly to forage yield. On some tests, however, yields more than doubled only 2 years after interseeding because growth of existing native grasses was stimulated. Houston estimates that yields on some ranges in poor condition may be increased four to six times once the full benefits of interseeding have taken effect.■

The new range interseeder developed by W. R. Houston and R. A. Adams is designed with commercially available parts. At right, Houston examines sand dropseed grass that volunteered between interseeded strips near Miles City, Mont. The dropseed is replacing blue grama, a less productive grass that had begun to dominate the area.

PN–1514, ST–1980–4



PN–1517

ARS PROFILE

Robert R. Oltjen, ARS beef cattle nutritionist, is challenging some long-held theories about cattle feeding to find better, more practical methods.

"With the expanding world population, the competition for feed grains and protein supplements will become intense," Oltjen explains. "We're trying to develop methods of feeding cattle that will result in less competition with the human population for these feedstuffs in the future."

Oltjen was instrumental in developing a completely purified (synthetic) diet that could maintain cattle for long periods. An important research tool, this diet is enabling scientists to study protein substitutes and improve feed efficiency.

Oltjen has also worked with all-concentrate rations to overturn such ideas as that roughage is required for efficient growth and that vegetable proteins are superior to urea in fattening rations.

Oltjen was raised on a livestock farm in Kansas, received his doctorate in 1961 from Oklahoma State University and joined ARS in 1962. He is the author or coauthor of more than 35 scientific papers and abstracts concerned mainly with beef cattle nutrition.

In the War Against Hunger, Scientists Study Protein Substitutes for . . .

BETTER LOW-PROTEIN F

WHY DO HIGH levels of urea in low-protein feeds reduce steer gains? An important question. In the future, increasing amounts of low-protein feeds will be fed to cattle as an expanding world population claims the high-protein plant foods.

Farmers often supplement low-protein feeds with inexpensive protein substitutes such as urea, but they limit urea to one-third of the total protein requirement of steers. Higher levels cause gains to decline.

To find out why, ARS nutritionists R. R. Oltjen and P. A. Putnam at Beltsville, Md., raised one lot of young steers on a diet containing purified soy protein and another lot on a similar diet in which urea replaced the soy. The rest of the ration was largely woodpulp, sugar, starch, and minerals.

Although steers on urea at first used 36 percent less of the nitrogen in their diet for protein production, steers on both diets used nitrogen more productively as the trial progressed, indicating that steers adapted gradually to the unusual test feeds.

The nutritionists found two important differences in nitrogen metabolism between steers on urea and on soy diets. Steers fed urea had (1) high levels of ammonia in the rumen immediately after meals, and (2) an imbalance of amino acids in the blood.

The first of these differences appears when nitrogen is released from urea as ammonia, the gaseous nitrogen compound that microbes in the rumen use to synthesize amino acids.

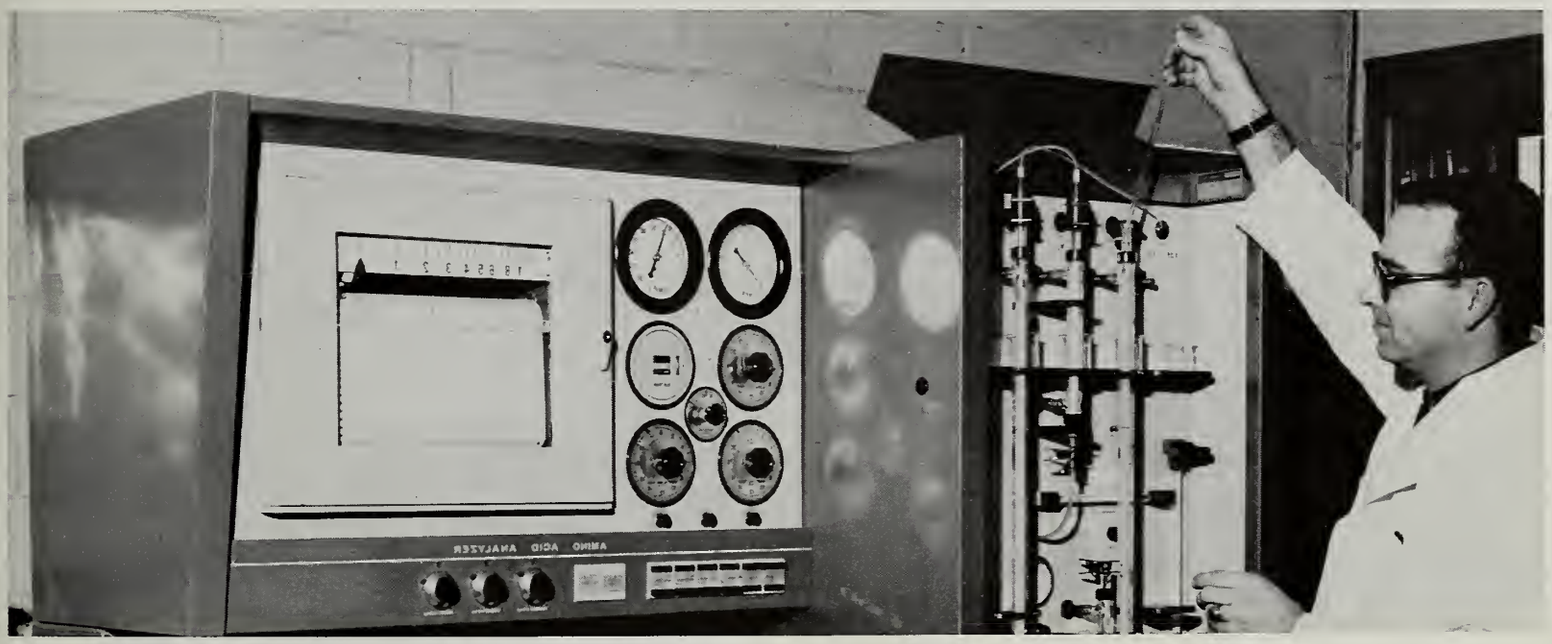
After steers on urea are fed, the ammonia level in the rumen quickly rises to four times that in steers on soy. A suddenly high ammonia level may be toxic and is wasteful because the excess ammonia is uselessly excreted.

The researchers are now looking for ways to avoid suddenly high levels of ammonia by pelleting or coating the feed to make urea dissolve more slowly. They are also testing other nitrogen compounds, such as biuret, which is converted to ammonia much more slowly and appears to offer other advantages.

The second important difference was found during an-

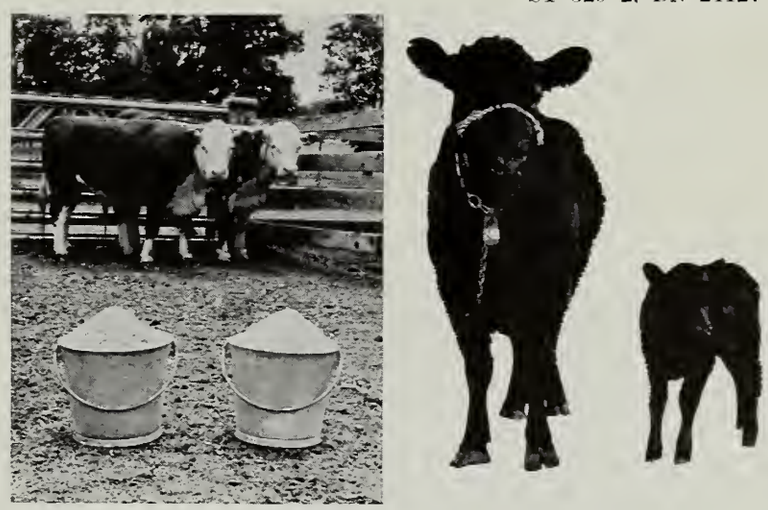
Below: A technician puts a sample of blood plasma in the amino acid analyzer for Oltjen's tests. Below left: in a previous study, groups of yearlings fed an all-concentrate ration and other groups fed the same concentrates plus 25-percent hay did equally well, challenging several long-held theories that have influenced cattle-feeding practices.

Below right: This 390-pound cow was fed from weaning on a protein-free diet. She gave birth to the 51-pound heifer calf shown. Below bottom: An Angus bull fed a protein-free diet with urea (right) at first grew more slowly than the other bull fed a purified diet with soy protein. The bull on urea later caught up with the soy-fed bull.



N–55692

ST–329–2, BN–24127



ST–771–9

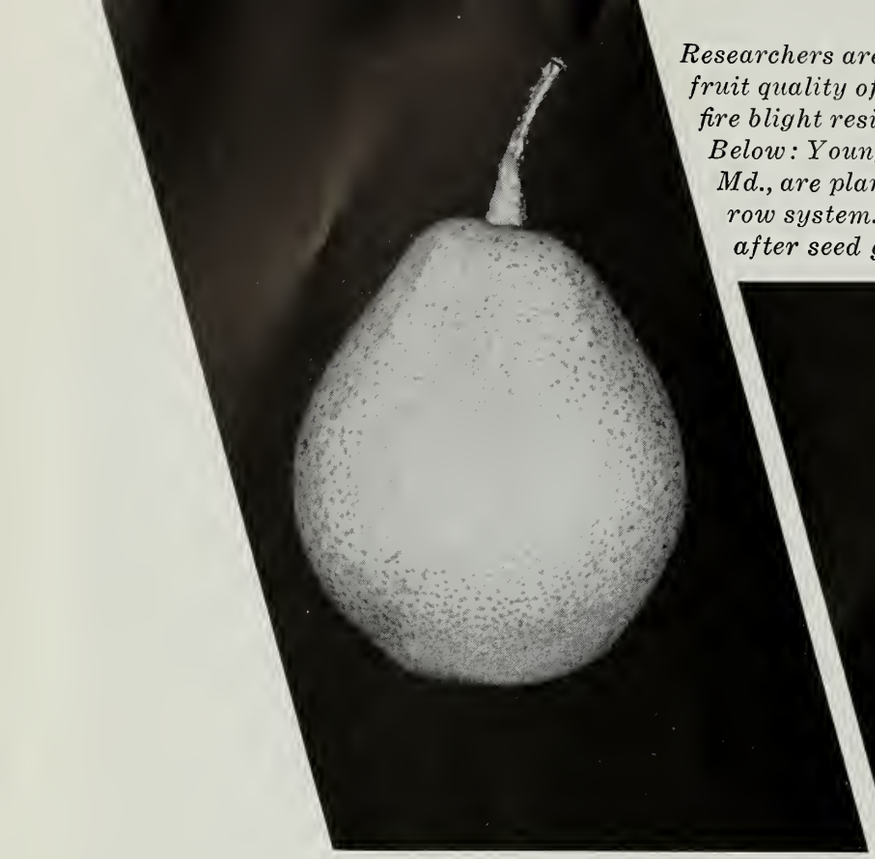
FEEDS

alysis of amino acids absorbed in the blood stream. Although the total level of amino acids in the blood plasma was similar for steers on both diets, the proportion of individual amino acids making up the total differed considerably.

The steers on urea had a higher proportion of serine and glycine in their blood plasma; but a lower proportion of valine, isoleucine, leucine, and phenylalanine. This imbalance of amino acids may result because the rumen microbes do not have sufficient branched-chain volatile fatty acids. These fatty acids are generally regarded as necessary for rumen microbes to manufacture certain amino acids.

Evidence indicates that these fatty acids are also essential for the growth of some rumen bacteria that digest cellulose and stimulate feed intake.

Oltjen and Putnam hope to find economical ways to provide steers on urea diets small quantities of the right fatty acids or to stimulate rumen microbes to synthesize them.■



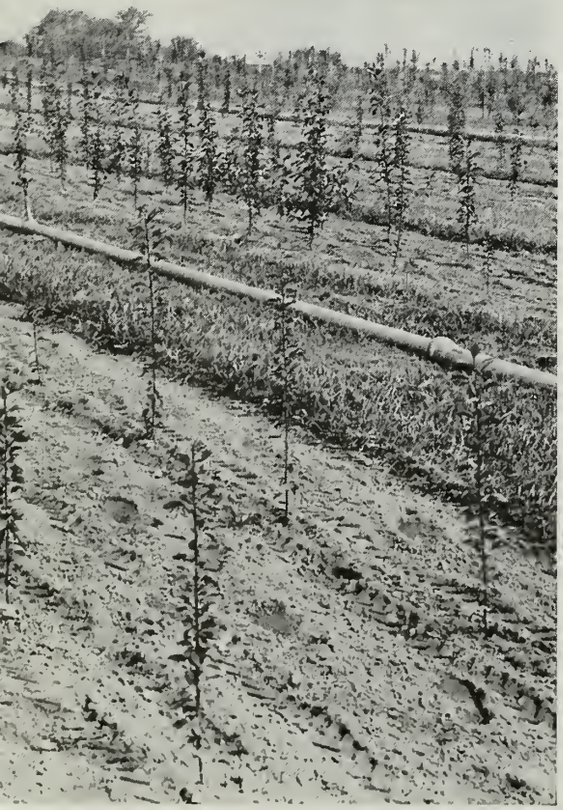
Researchers are trying to combine the high fruit quality of Pyrus communis *with the fire blight resistance of* Pyrus calleryana. *Below: Young pear seedlings at Beltsville, Md., are planted in a double-staggered row system. Photo was taken 22 weeks after seed germination.*

PN–1518

Aiming for Abundance in

HIGH-QUALITY PEARS

PN–1519



AN ARS PEAR-BREEDING project aims to bring consumers an abundance of high-quality pears with resistance to fire blight.

Fire blight, a bacterial disease, kills blossoms, twigs, branches, and, frequently, the entire tree. Infected trees look as if they have been scorched by fire. In the United States, fire blight has limited most commercial production of high-quality pears to the Pacific Coast States. Even there, no orchards are entirely free of the disease.

The ARS pear-breeding program is centered at Beltsville, Md. Horticulturist H. J. Brooks and plant pathologist Tom van der Zwet are currently evaluating 15,000 seedlings from controlled crosses. At Wooster, Ohio, ARS horticulturist William Oitto is evaluating 1,200 seedlings in a cooperative program with the Ohio Agricultural Research and Development Center.

To reach their goal of 40,000 seedlings, the researchers will plant 2,500 seedlings each year at Beltsville and 1,500 at Wooster. They will remove all seedling trees after 10 years to make room for new plantings. Only seedlings of known parentage are used and after complete evaluations, only about 1 in 300 are saved for further testing.

An integral part of the breeding program is perfecting a method to screen seedlings for fire-blight resistance before planting. Seedlings susceptible to fire blight do not become infected until they are 5 or 6 years old, and such a preplanting screening technique would greatly increase the efficiency of the research

program.

The scientists also hope to determine the effect of growth and environment on juvenility, the period a seedling tree grows without producing flowers.

The only pear species grown commercially in the United States is *Pyrus communis*. ARS pome fruit specialists are evaluating a collection of *Pyrus* species for resistance to fire blight and for other characteristics. They are also evaluating 838 varieties and selections for fruit and tree characteristics in addition to fire-blight resistance.

Most seedlings, for example, do not bear fruit until they are 6 years old or more. Some may fruit as early as the third year, however, and the more precocious seedlings will be used to breed lines retaining this early fruiting characteristic.

The time required for seedlings to bear fruit, for breeders to perfect a new variety and for commercial nurseries to increase it as well as for growers to get orchards into production all delay the availability of a new pear to the consumer.

ARS has conducted its pear-breeding program in the present form since 1960. Now, genetic studies have been added and tree, disease, and fruit characteristics are recorded for each tree.

Fruit type data—color, shape, size, flavor, freedom of grit, texture, russet, and general appearance—are weighted according to their importance to overall fruit quality. Flavor and absence of grit cells are judged more important than general appearance.

While detailed fruit characteristics are recorded from stored fruit samples, juvenility and disease characteristics are recorded in the field. All evaluations are made using a numerical system so information can be transferred to data processing cards for computer analysis. ■

PN-1526

Arvin Mosier, a chemistry student at Colorado State University, divides a soil column into sections to test for pesticide content.

DDT LEACHING TESTS

DDT does not move readily through the soil—consequently, there is little chance that DDT applied to cropland can be leached downward through the soil and into the water table.

Soil scientist W. D. Guenzi and chemist W. E. Beard tested four types of soil, ranging from sand to clay. The soils were placed in columnar containers 7 inches high and 4 inches in diameter. The top inch of soil was removed from each column, mixed with DDT, and replaced.

Water was applied to the columns at rates equivalent to 5 inches, then 10 inches, of rainfall. One set of columns received water continuously, another was dried with a fan between waterings. At the conclusion of the experiment, the columns were sliced into 1-inch layers. Each layer was tested for DDT content.

Virtually all of the applied DDT was found where it had been placed—in the top inch of soil. The amount of DDT recovered was not significantly influenced by soil type, amount of water applied, or method of applying water. The chief factor preventing DDT movement in the soil is probably its low water solubility, the researchers said.

Another pesticide, lindane, was subjected to the same tests in a companion experiment. Movement of lindane was influenced by soil texture and amount of water applied. At the heavier watering rate, lindane penetrated to a depth of 5 inches in a sandy soil and to a depth of 2 inches in a clay soil.

Less lindane was recovered than DDT from soils that were wet and then dried. Lindane has a higher vapor pressure than DDT, and more of it was probably lost by evaporation from the soil during the experiment.

Because DDT is extremely stable and resistant to movement through the soil, it can build up in areas where it is used regularly. Guenzi and Beard are working on methods to reduce such accumulations, possibly through use of anaerobic microorganisms (AGR. RES., May 1967, p. 13).

The researchers, both stationed at the ARS Nitrogen Laboratory, Ft. Collins, Colo., are conducting their work in cooperation with the Colorado Agricultural Experiment Station. ■

On-Off Control for

Automatic Irrigation

PUSH-BUTTON FARMERS of the future will have one less button to push, thanks to ARS soil scientist H. R. Haise. His automatic irrigation system turns itself on and off.

The hydraulically operated floodgates of the system are linked to moisture sensors buried in the irrigated field. The sensors form part of a battery-powered electrical circuit.

As long as the sensors are dry, the gates remain open and water flows over the field. But when water infiltrates the soil deep enough to wet the sensors, the elecrical circuit closes and the current triggers a mechanism that shuts off the flow. As soil moisture is taken up by plants, the sensors dry out, the circuit is broken, and more water is released.

The need for automatic irrigation stems from a scarcity of skilled farm labor; gate-tending on conventionally irrigated fields is a tedious and time-consuming job. In the long run, however, automatic irrigation may be valuable chiefly as a means of saving water. Irrigation farms now account for about a third of annual water consumption in the United States. Much of this water is wasted because of a lack of efficient irrigation systems.

In laboratory tests, Haise's system worked perfectly through thousands of valve openings and closings. It has also been used experimentally on sugarcane fields in Hawaii.

A system of stilling wells and floats is used to get water from the field supply ditch to feeder ditches, then to furrows. Inside the stilling wells are inflatable rubber valves, connected by hoses to a tank of compressed air. Compressed air is pumped into the valves at a signal from the soil sensor. The inflated valves "override" the action of the float system and shut off the water. Another signal releases air from the valves.

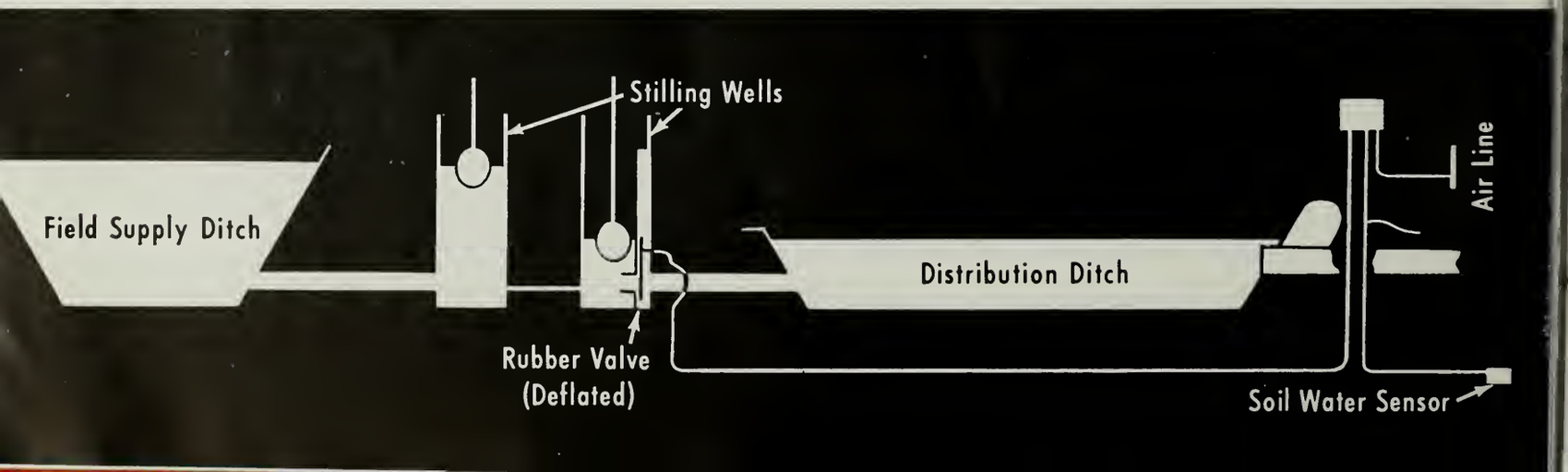
Resistors can be added to or removed from the electrical circuit to vary the triggering points of the system. After determining the porosity of the soil, plus the water requirements of plants to be grown in the soil, technicians can arrive at triggering points that will ensure the most efficient use of irrigation water.

Haise is stationed at Colorado State University, Ft. Collins, and works in cooperation with the Colorado State Experiment Station. His sensor-controlled irrigation system is the most novel of several systems he has designed in recent years. One of his chief aims is developing inexpensive automation principles that can be used on existing irrigation systems (AGR. RES., August 1965, p. 2). ■

PN–1520

Above: Technician William Reynolds of the Hawaii Sugar Planters Association checks the automatic gates in tests on a Hawaiian plantation. Stilling wells are at left. Below: The inflatable rubber valves inside the stilling wells are connected to a tank of compressed air. When the soil sensors become wet, a signal is sent to the air tanks which inflate the valves, shutting off the water.

PN–1521



PN–1522

Laboratory technician C. D. Wakefield measures the surface temperature of the soil with a radiothermometer. The "eye" of the device is mounted on top of the tripod; the apparatus at left records the data.

MEASURING AIR POLLUTION

RADIATION FROM the sky may provide a means for measuring air pollution in smogbound cities.

Jack Conaway, a University of California graduate student working with ARS physicist C. H. M. van Bavel at the U.S. Water Conservation Laboratory, Phoenix, Ariz., invented this novel monitoring technique while conducting experiments with soil temperature.

Conaway was using an infrared radiothermometer to measure the amount of sky radiation reflected from the soil surface when he found that the sky radiation measurements changed drastically from hour to hour. The changes did not seem to be related to temperature, humidity, or any other readily discernible factor.

On a hunch, Conaway went to the air pollution branch of the local county health service and looked up the records of ozone content in the air during the periods covering his experiments. He found that the variations in ozone content and the variations in his radiation figures were strikingly similar. Ozone, one of the chief air pollutants in many heavily populated areas, is formed by the action of sunlight on exhaust fumes.

Present methods of measuring pollution require taking samples of the air and analyzing it chemically. The size of the area that can be sampled at one time is therefore limited.

An infrared beam of the right wavelength, directed at a nearly horizontal slant through the air above the earth's surface, could provide an instantaneous check of pollution over a large area. If ozone does affect radiation, as Conaway theorizes, and if the effect can be measured by a radiothermometer, pollution measurement would be faster and more effective.

Conaway and van Bavel emphasize that at this point their conclusions are based on scant data.

Besides pollution monitoring, van Bavel suggests one other possible consequence of the ozone-radiation relationship: Weather satellites circling the earth record surface temperature with an instrument similar to the one used by Conaway. If ozone at the earth's surface affects earth-based measurements, it may also affect measurements made from space when satellites pass over polluted population centers. ■

A Dieter's WHITE CAKE

PN–1523

Food chemist P. A. Simandle shears a cake sample to test tenderness—the less force needed, the greater the tenderness.

DIET-CONSCIOUS homemakers can leave half the fat out of cake batter and still produce a cake that looks and tastes good.

A typical cake recipe calls for about one part fat for every four parts flour. In trials at Beltsville, Md., ARS food specialist R. H. Matthews reduced this standard proportion to one part fat for every eight parts flour for some white cakes, and even lower, to one part fat for every sixteen of flour for other white cakes.

Cakes with half the standard fat content looked as appealing as regular cakes to members of a taste panel. Volume of low-fat cakes was similar to that of standard cakes, indicating that proper rising was no problem. Cake volume dropped about one-fifth, however, when fat content was reduced to one part fat for every eight parts flour.

The taste and feel of the cakes with half the usual fat content were a little lower than for regular cakes, according to the taste panel, which noted a small reduction in tenderness and velvetiness. The machine tests for tenderness paralleled scoring by the taste panel.

Test cakes at different fat levels varied in the type of fat put in the batter. Some cakes were made with all vegetable shortening, some with blended vegetable and animal-fat shortening, some with butter, some with corn oil margarine, and some with other margarine.

The kind of fat did not significantly affect appearance of the cakes with reduced fat content, but taste and tenderness were highest with butter or margarine.

The food specialists also evaluated other low-fat baked products. Muffins, they found, can be made with half the amount of fat. Biscuits can be made with two-thirds as much, and pastry with three-fourths as much. In each case, taste panels noted a reduction in tenderness and flavor, but they found that the products were highly acceptable nevertheless. ■

Weight Losses in SNAP BEANS

UNLIKELY AS IT seems, the number of hairs on snap bean pods definitely affects weight losses during harvesting and marketing operations.

Tests show that when all other characteristics are similar, snap bean pods with a high hair count lose more weight than pods with a low count. During harvesting or marketing operations, hairs are broken or pulled from the surface, often taking surface tissue with them. As the number of broken or missing hairs increases, the weight loss increases.

ARS research horticulturist J. C. Hoffman made these findings while investigating weight losses and wilting at the U.S. Vegetable Breeding Laboratory at Charleston, S.C. He recorded average weight losses of 17 percent for beans harvested in the spring and stored for 3 days, and 42 percent for beans harvested in the fall and stored for 7 days. In both instances room temperature was approximately 70° F., and the relative humidity varied from 70 to 80 percent.

Hair count was correlated with weight losses in both seasons. The scientists found the correlation highly significant.

When snap beans lose weight, or wilt, while in storage, farmers, middlemen, and consumers are affected. Hoffman suggests that weight losses between the field and the supermarket or processing plant can be reduced if quality varieties relatively free of hairs can be developed.

Such varieties would give the farmer a better product to offer the wholesaler or processor, the wholesaler and processor a better product to offer the retailer, and the retailer a better product to offer the consumer.

In commercial snap bean production, injuries such as end breakage cause weight losses, but Hoffman prevented these injuries in his investigations, so that they could not affect results.

Hoffman also found that seven other anatomical characteristics did not affect weight losses. These were cell diameter in the mesocarp and endocarp tissues of the beans, and thickness of the mesocarp, endocarp, exocarp, epidermis, and cutin layers of tissue.

Pesticide Controls Citrus Nematode

Southwestern citrus growers can control the citrus nematode in their groves by treating the soil with DBCP pesticide.

Nematologists H. W. Reynolds and J. H. O'Bannon proved the effectiveness of DBCP (1,2-dibromo-3-chloropropane) during a 10-year study conducted in Arizona orange and grapefruit groves. The Arizona Agricultural Experiment Station cooperated in the project.

The citrus nematode severely damages citrus trees by embedding its head in the smaller roots and eating the cell contents. This feeding causes the branches to die from the tip inward, a condition known as slow decline.

DBCP destroys most of the nematode population with the first application. Within a few months after treatment, the trees regain their health and begin to produce more and larger fruit. Surviving nematodes gradually build up, however, and the treatments should be repeated every 3 to 5 years depending on the rate of buildup and the dosage used in the initial application.

In the first year of tests, Reynolds and O'Bannon found that Valencia orange trees on a treated plot yielded 39 percent more cartons of fruit than trees on an untreated plot.

During the second year, the trees yielded 57 percent more cartons of fruit. In addition, trees on the treated plot yielded larger, more marketable and a higher percentage of premium-grade fruit.

In tests with navel orange trees, the researchers recorded yield increases of 12, 38, and 24 percent, respectively the first 3 years after treatment. In the same tests, the size of the oranges increased 22 percent the second year and 11 percent the third year.

Fruit from grapefruit trees on a treated plot increased 278 percent in size over a 7-year period. In one test, trees on treated plots yielded 154 percent more fruit by weight than those on untreated plots.

DBCP is applied to the soil by mixing with irrigation water. From 2 to 6 gallons per acre of the emulsifiable concentrate DBCP is added to 4 to 6 acre-inches of irrigation water. The water is distributed by flood irrigation. An acre-inch of water is the quantity required to cover 1 acre of ground to a depth of 1 inch.

Herringbone For All Herds

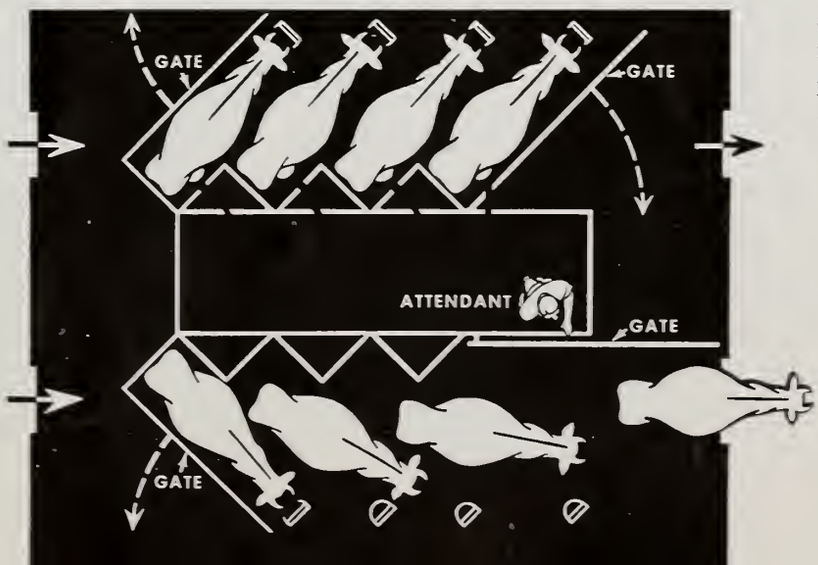
Herringbone milking layouts, besides providing faster, more efficient milking of dairy herds than other types of milking systems, also adapt well to a wide range of herd sizes.

ARS agricultural engineer Thayer Cleaver reached this conclusion after a study of 57 herringbone parlors ranging in size from layouts with 2 rows of 4 cows each to 2 rows with 12 cows each. Herd sizes varied from 37 cows in lactation to 760. Most of the cows tested were Holsteins. The California Agricultural Experiment Station at Davis cooperated in the study.

Herringbone layouts required less stooping, bending, and walking than conventional milking barns. These features plus the compactness of the herringbone mean faster milking, more efficient use of labor, and lower building costs per cow.

Despite the labor-saving revolution in agriculture, dairying continues to require a lot of labor at the milking stage. It still takes manpower to move cows in and out of the milking parlor, prepare them for milking, attach milking cups, operate feeding devices and clean up. Increasing milk output on dairy farms has accentuated this bottleneck. Herringbones permit near-capacity operation of pipeline milkers, bulk tanks, and overhead automatic feeders. There is little or no dead time during milking.

In addition, herringbone layouts save space by placing cows in two rows along opposite walls and angled outward at about 30°—as is in the herringbone weave. A pit working area down the center separates the rows. Each cow stands snugly against her neighbor, head toward the outer wall. The cow, positioned at an angle, juts her rump just beyond the neighbor's. This makes udders readily ac-



Herringbone milking parlor.
PN–1524

cessible and gives the operator space for chores.

In some areas, dairymen have been slow accepting herringbones and other types of elevated stalls because of the high cost of changing from one system to another. However, many dairymen who have had to relocate their dairies have switched from conventional to elevated types. Those who switched to a herringbone give these reasons for the change:

- Lower investment in the milking structure;
- Fewer milkers are required;
- The milking rate per operator is generally higher;
- Herd size can be increased without increasing the number of operators;
- Less labor turnover because of easier milking operations.

RF Injures Yellow Mealworms

Yellow mealworm larvae exposd to less than lethal doses of radiofrequency electric energy develop into adult beetles with deformed or missing legs.

The deformities are probably the result of a rapid buildup of heat in the histoblat tissues, which lie in conducting paths of the RF current. The histoblasts project into legs during the final larval stage.

Only partial adult leg development followed 0.5- to 2-second RF exposures of the larvae while leg development was completely inhibited after 2.5- to 4-second exposures. Similar RF treatments of larvae at an earlier stage of development did not interfere with normal leg growth, possibly because the histoblasts were not as prominent.

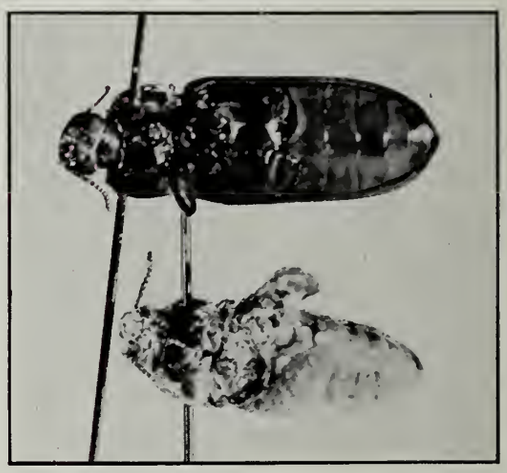
The larvae study is part of continuing research to develop effective, economical ways to use RF energy for destroying insects in stored grain and seed. Unlike fumigation, RF treatment does not leave chemical residues and can be applied uniformly throughout a mass of material in a very short time—often within seconds.

Tests were conducted by entomologists A. M. Kadoum of Kansas State University, H. J. Ball of the University of Nebraska, and ARS agricultural engineers S. O. Nelson and L. E. Stetson at Lincoln, Nebr.

Previous experiments with infested grain show that RF energy—employed in a process called dielectric heating—has potential for controlling rice weevils, granary weevils, lesser grain borers, red flour beetles, confused flour beetles, cadelles, and dermestids. Complete destruction of these insect pests without damage to the infested grain has been accomplished experimentally.

In the RF process, the material to be treated is placed between two electrodes that are connected to a source of high-frequency electric energy. The electromagnetic fields produced in the material oscillate at millions of times per second. The material under treatment, grain for example, is itself a "dielectric," or relatively nonconducting, substance. Its molecules are stressed first one way and then another at great rapidity by the force of the alternating field.

This stress quickly heats the grain or seed. Temperatures reached depend upon the voltage applied to the electrodes, the distance between them, the nature of the material, and the length of time the RF energy is applied.



PN-1525

These adult mealworms were exposed to RF energy in the final larval stage for 1 second (top) and 4 seconds.

Most of the tests conducted to kill insect pests in stored grain were made using frequencies of about 10 and 40 megacycles. A frequency of 39 megacycles was used in the yellow mealworm tests.

CAUTION: In using pesticides discussed in this publication, follow directions and heed precautions on pesticide labels. Be particularly careful where there is danger to wildlife or possible contamination of water supplies.

U.S. GOVERNMENT PRINTING OFFICE: 1967